CLAIMS

[1] A projection optical system for forming a reduced image of a first surface onto a second surface:

a first reflective imaging optical system for forming an intermediate image of the first surface and a second reflective imaging optical system for forming an image of the intermediate image onto the second surface;

the first reflective imaging optical system including a concave first reflector, a concave second reflector equipped with an aperture stop, a convex third reflector, and a concave fourth reflector successively as light enters from the first surface side;

the second reflective imaging optical system including a concave fifth reflector, a concave sixth reflector, a convex seventh reflector, and a concave eighth reflector successively as light enters from the first surface side.

[2] The projection optical system according to claim 1, wherein the fourth reflector is arranged in a space between the second and third reflectors.

[3] The projection optical system according to claim 2, wherein the position of the fourth reflector satisfies the condition of

$$0.2 < d1/d2 < 0.8$$

where

d1 is the surface separation between the third and fourth reflectors, and

d2 is the surface separation between the second and third reflectors.

[4] The projection optical system according to one of claims 1 to 3, wherein absolute values of radii of curvature of all the reflectors fall within the range of 300 mm to 5000 mm.

[5] The projection optical system according to one of claims 1 to 4, satisfying

$$400\ \text{mm} < R3 < 2000\ \text{mm}$$

where R3 is the radius of curvature of the third reflector.

[6] The projection optical system according to one of claims 1 to 5, satisfying

$$0 < R2 < 3000\ \text{mm}$$

where R2 is the radius of curvature of the second reflector.

[7] The projection optical system according to one of claims 1 to 6, satisfying

$$0 < R6 < 4000\ \text{mm}$$

where R6 is the radius of curvature of the sixth reflector.

[8] The projection optical system according to one of claims 1 to 7, wherein the image-side numerical aperture NA is no less than 0.3.

[9] An exposure apparatus comprising an illumination system for illuminating a mask set on the first surface, and the projection optical system according to one of claims 1 to 8 for projecting and exposing a pattern of the mask onto a photosensitive substrate set on the second surface.

[10] An exposure apparatus according to claim 9, wherein the illumination system includes a light source for supplying an X-ray as exposure light, and projects and exposes the pattern of the mask onto the photosensitive substrate by moving the mask and photosensitive

substrate relative to the projection optical system.